

CONFIDENTIAL

50X1-HUM

The "Elektroapparat" Plant laboratory has, among other things, investigated the electromagnetic and thermal processes in current transformers, the thermal and electrodynamic phenomena in equipment, the thermal phenomena in contact equipment and the processes of arc-quenching in breakers.

This research served as a starting point for the design of the high-voltage equipment which is produced by the plant. The Electrical Instrument Laboratory of the Leningrad Electrical Engineering Institute did interesting work in the study of free arcs and the conditions of their extinguishment, the movement of arcs in a magnetic field, on problems of the heating of equipment and busbars, and in the development of special measuring instruments such as pressure indicators, oscillographs, and other instruments.

Design departments in various plants have been responsible for the development of such important high-voltage equipment as VM, MCG, MKP, and other circuit breakers, current and voltage transformers, disconnecting switches and other types of equipment.

High-Voltage Circuit Breakers and Operating Mechanisms

Serious development of high-voltage breakers began at the "Elektroapparat" Plant in 1925. The VM series (VM-5, VM-14, VM-18, VM-22, VM-103, and VM-125) appeared first. Although they were adequate for a number of years, none of these are being produced now. The increased demands of power systems required that oil breakers be redesigned, and as a result, new and better types appeared (the VM-16, VM-23, VM 35, and others).

During 1931 - 1934, the 10-kilovolt "low-oil" breakers MCG-223 and MCG-229, were successfully designed for stations and substations with an interrupting capacity of 500 and 1,500 millivolt amperes and are still in use. About the same time there appeared a series of heavy duty high-voltage substation breakers, the MKP-76, MKP-153, the MKP-183, and the MKP-274 (for 35, 110, 154, and 220 kilovolts).

In 1935, the "Uralslektroapparat" Plant produced a low-power breaker, the VMG-22 (6 kilovolts, 400 amperes), redesigned later as the VMG-33 and the VMG-133 (10 kilovolts, 600 amperes, 350 millivolt amperes). "Low-oil" breakers for high voltages (35 to 110 kilovolts) were investigated, but only experimental models were actually built.

The need for high-speed heavy-duty switches, is increasing with the growth of power systems. The MKP series is unsatisfactory from the point of view of durability. Recently, work was begun on a domestic series of air breakers for 35, 110, 154, and 220 kilovolts.

Air breakers have better technical and operational properties than oil breakers and require considerably less material to build. They are explosion proof easy to inspect, and superior in a number of other ways. The air breakers being produced by Soviet plants are superior to well-known foreign makes in several respects.

The VEI is working out a new 35-kilovolt breaker. Maximum simplicity is combined with high speed and large interrupting capacity.

In 1947 the "Elektroapparat" Plant started production of autogaseous breakers (gas-producing), with manual spring operation for 10 kilovolts, 250 - 300 millivolt amperes (VG-10) with arc-extinguishing chambers developed in the VEI. These breakers can be used on the equipment of distributing grids and plant substations. A new type of arc-extinguishing material is employed in this switch. Autogaseous breakers are explosion proof and possess

- 2 -

CONFIDENTIAL

CONFIDENTIAL

50X1-HUM

great durability under working currents and short circuits. A comparison of the domestic autogasous breaker with one from the AEG firm showed that the latter was of poorer quality and was less durable. A series of operating mechanisms (of the electromagnetic and motor type) for oil breakers was also developed simultaneously with the switches. The first series of electromagnetic operating mechanisms, GP-40, GP-80, GP-125, and PS-175, was developed by the "Elektroapparat" Plant before 1930. The introduction of the breaker series MKP and MGK required the production of the heavier-duty and improved operating mechanisms PVS-150, PVM-4, and PVM-108 which are still in use. In time, the need for the more modern solenoid series, PS-10, PS-20, and PS 30 became evident.

Fuses and Power Disconnects

Frewar fuses were inadequate. Their low breakdown voltage (15 kilovolts) and flareback limited their use. Work begun in the VEI before the war led to the development of a new series (PK) with quartz filling for voltages of 3, 6, 10 and 35 kilovolts, with breakdown voltage as high as 200 kilovolts and for nominal currents up to 50 amperes. Fuses with quartz sand have the remarkable properties of restricting short-circuit currents, breaking the circuit without causing noise, flareback, or gases. In 1946 the nominal current for fuses was raised to 100 amperes and in 1947 to 200 amperes.

The VEI also developed new fuses (PKT) with high breakdown voltage to safeguard against short circuits in transformer voltages. These fuses are not very large and have the same case for 3, 6, and 10 kilovolt voltages, due to the use of a graduated fusible insert. They do not require the series inclusion of a current limiting resistance. Hence, the PKT fuse is very compact.

The production of fuses with high breakdown voltage for nominal currents raised the problem of new devices, called power disconnects, intended for cutting out operating currents. The combination of power disconnects and fuses often makes it possible to replace circuit breakers with corresponding apparatus in disconnect switches, operating mechanisms, current transformers, relays, and other equipment. In 1945, "Elektroapparat" started production of power disconnects with 6-kilovolt 200-ampere capacity.

High-Voltage Disconnecting Switches

A disconnect is a comparatively simple device, but because of heavy operating conditions (currents of 3,000 - 5,000 amperes) it requires constant improvement by designers and research workers in electrical equipment plants. At a number of plants important research has been carried on for several years on contacts and de-icing methods.

In 1935 - 1936 the "Uralslektroapparat" Plant developed a series of normal disconnects with magnetic terminals. The terminals have made it possible to increase considerably the electrodynamic and thermal stability of the disconnects. The plant is still producing this series. The plant is also producing a new series of disconnects of 6 - 10 kilovolts with a laminated fixed contact which has substantially simplified the technology of production.

"Elektroapparat" is producing an interesting new series of 35 and 110 kilovolt disconnects for outdoor installations with a knife blade revolving around its axis in the zone of the fixed contact and with a subsequent increase in the surface area of the insulators.

- 3 -

CONFIDENTIAL

CONFIDENTIAL

50X1-HUM

These disconnects satisfy the conditions of ice removal and guarantee reliable contact and a small disconnecting moment. This series of disconnects for voltages of 35 and 110 kilovolts is already in mass production. It is being further developed for outdoor installations in the 154- and 220- kilovolt class. These new high-voltage disconnects still need operating verification, but unquestionably represent a rational design.

Current and Voltage Transformers

Prewar industry produced current and voltage transformers for all voltages up to and including 220 kilovolts. The majority of the types are up-to-date from a technical point of view. A comparison of the weights and measurements of the products of "Elektroapparat" Plant, including TFN high-voltage current transformers and NKF cascade-voltage transformers for 110 - 220 kilovolts, with foreign makes indicates that the domestic products are superior in their respective precision classes.

Arresters for Protection Against Excess Voltage

At present, excess voltage is guarded against by the use of valve and tubular arresters. The first valve arrester appeared in the USSR in 1932. This model was discontinued in 1934 - 1935. In 1935 the "Elektroapparat" Plant began to produce fergusonite arresters, but they, too, were inadequate because of the low quality of the resistant material and the unsatisfactory design, which permitted air leakage. In the RTNM and RZSN arresters put out by "Elektroapparat," the residual voltage during the flow of high-impulse currents proved to be too high. As a result, before the war, the VEI tried to find new types of nonlinear resistances. A special sort of carborundum was used for the resistance and a new process worked out for producing the resistances themselves. In addition, the properties of the spark gap were substantially improved.

As a result, in 1944 a new series of VEI arresters were introduced for voltages of 3, 5, 10, and 35 kilovolts.

The new arresters are distinguished by their greater compactness, lower weight, simpler production processes, and greater protective qualities. Plans were made for arresters with 110- and 220-kilovolt capacity, but investigations showed that they were less effective than a system of high-voltage arresters whose spark gap is securely shunted with resistance. On the basis of this research, a new series for 35, 110, 154, and 220-kilovolt voltages was developed.

Tubular arresters (RT) were developed by the "Elektroapparat" Plant and later by the "Uralkalektroapparat" for voltages up to 110 kilovolts, on the basis of fibrous bakelite tubes. But these arresters were inadequate because of the low electrical surface resistivity of the tube under the influence of atmospheric conditions. In addition, operation of the tubular arresters requires annual dismantling toward the end of the storm season and repeated adjustment at the beginning of the season.

Dismantled tubes require annual drying and lacquering before they are replaced on the line. In spite of the large operational expenditure and the shutting down of the transmission line, there was still no guarantee against breakdowns. VEI decided to use a new material which possessed a very high moisture resistance but insufficient resistance to impulse loads. At present, tubular arresters made of the new material are produced only for small currents. Attempts are being made to produce a more durable tube by covering it with a mechanically durable and waterproof coating of insulating material.

- E N D -

- 4 -

CONFIDENTIAL